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MILITARY OPERATIONS RESEARCH SOCIETY WORKSHOP ON COMBAT
SCORING SYSTEMS (U) MILITARY OPERATIONS RESEARCH
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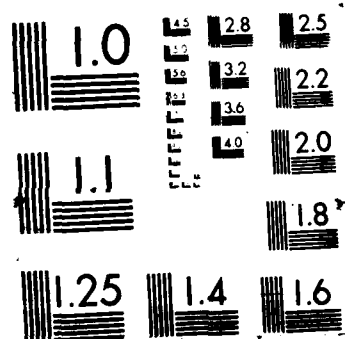
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SOCIETY WORKSHOP



Combat Scoring Systems

(COMSCORS)

N00014-86-C-0036

US Naval Postgraduate School
November 12 - 14, 1986

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**Combat Scoring Systems
(COMSCORS)**

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**US Naval Postgraduate School
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FINAL REPORT

MILITARY OPERATIONS RESEARCH SOCIETY WORKSHOP ON COMBAT SCORING SYSTEMS (COMSCORS)

Dr. Sam H. Parry, US Naval Postgraduate School
Associate Professor of Operations Research

Background

The Combat Scoring Systems (COMSCORS) Workshop was proposed by Walter W. Hollis, Deputy Under Secretary of the Army (Operations Research) (DUSA(OR)). It was conducted 12-14 November 1986 at the Naval Postgraduate School, Monterey, CA. The main objective was to discuss and evaluate existing weapons scoring systems and estimate the need for and desirable characteristics of future systems of this kind. The terms of Reference are at Appendix A.

Purpose and Scope

In his keynote speech Mr. Hollis offered five general items of guidance for the sessions:

- > Shed light on conceptual issues.
- > Focus on internal consistency rather than rigor.
- > List problems that should not be addressed with scores.
- > Determine why such wide variations occur in the application of various scoring systems and the sources and causes of these variations.
- > The goal is not to select a preferred scheme.

Conclusions

The workshop reached the following conclusions:

- > Our current scoring systems do not suffice.
- > We do not know how to fix the problems.
- > We must develop a structured approach to realize acceptable methodologies for tractable and believable value systems usable in the DOD decision processes at the hierarchical levels. Current simple, static (and easy to manipulate) scoring systems will continue to be used (and the number of versions of these will proliferate) until acceptable alternatives are produced.

Recommendation

Resources should be dedicated and fenced NOW if any progress is to be made in this area. More workshops are NOT the answer.

Organization

The workshop was chaired by Professor Sam Parry of the Naval Postgraduate School. CDR Joe Stewart, also of the Postgraduate School, was Co-Chair. Dr W. Peter Cherry, Vector Research, Inc; Kenneth Lavoie, Air Force Wargaming Center at the Air University and Daniel Shedlowski, US Army Concepts Analysis Agency were Working Group Leaders. Other participants are listed in Appendix B.

The workshop got underway in a General Session. Walter Hollis delivered the keynote. After introduction of the working group leaders and delivery of the charge, the working groups, Mathematics, Attrition Processes and Non-Attrition Processes, went to work on the problem. For the next three days the working groups met individually, in groups of two and in general sessions to air the problem and develop conclusions and the recommendation. The Agenda is at Appendix C.

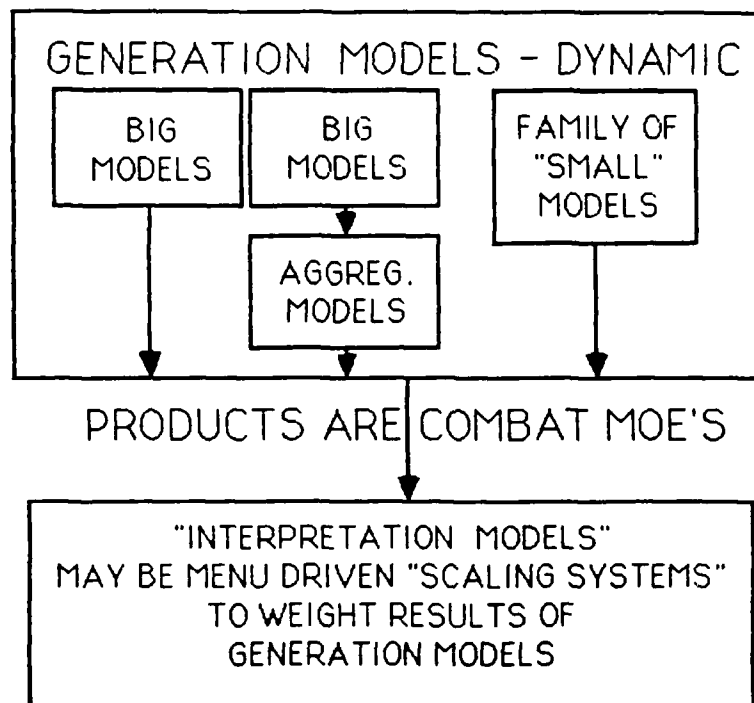
Overview of Workshop Discussions

As expected, the first day was spent in free-for-all exploratory sessions trying to establish foundations for our deliberations. The members of the workshop represented a wide variety of backgrounds and a good mix between modelers/analysts and users of the products. There was little disagreement from the beginning that static, linear, aggregated scores as stand-alone methodologies for answering questions are very undesirable. There was little initial agreement as to what to do about the problem.

On the second day it was proposed and accepted that we would break the problem into two components: generation and interpretation (see Figure 1). The generation component is the producer of quantitative combat measures of effectiveness, subject to professional review, verification, and (hopefully) validation. Interpretation is the process of mapping generation component outputs into answers to specific questions, hopefully subjected to professional review based on decision and utility theory notions to provide a much needed audit trail through the process.

A second fundamental categorization of the relationship of decision classes, force size (model resolution), and process importance provided a very useful enhancement to viewing the problem (see Figure 2). Attrition process importance decreases (relative to non-attrition processes as force sizes increase from battalion to theater level. Also the questions asked (and decisions required) change over this continuum. Finally, Figure 2 shows an initial categorization of non-attrition processes importance along this continuum.

FIGURE 1



Characteristics of Generation Models

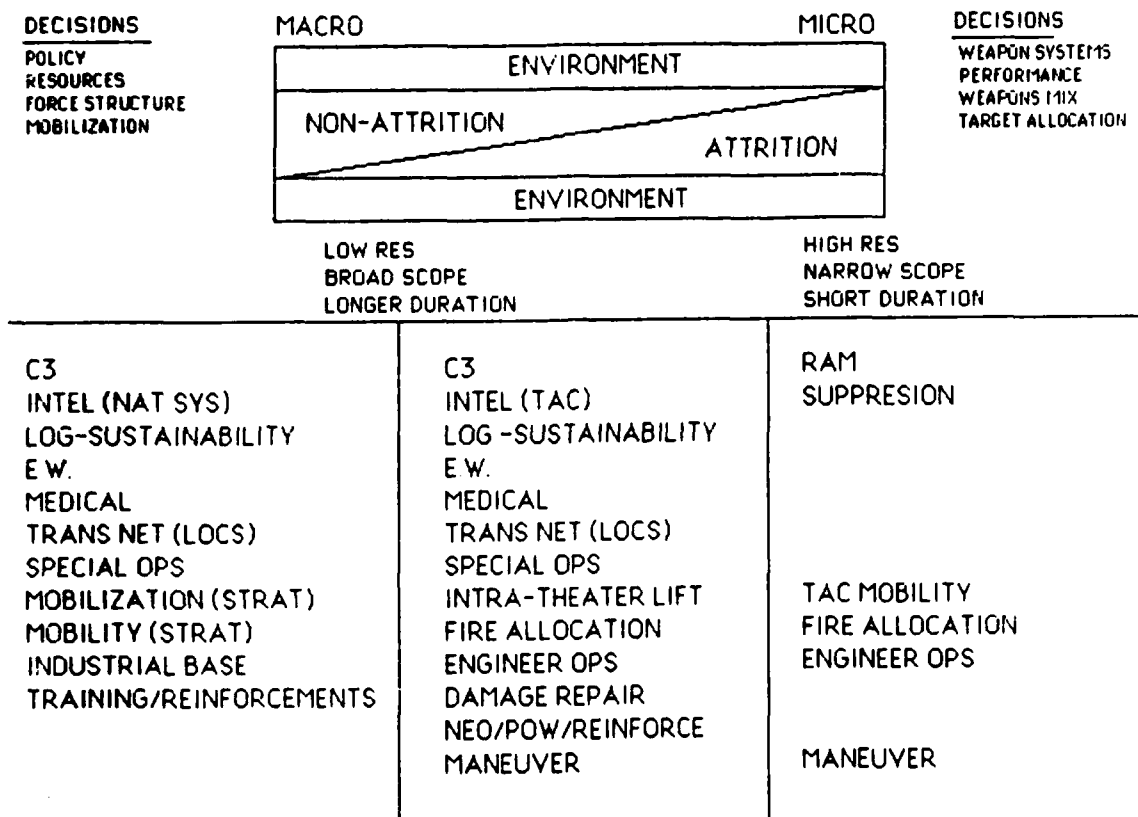
Probably the most desirable attribute of generation models is that they represent the dynamics of combat over time. The products of generation models are combat measures of effectiveness (MOE) such as dynamic killer-victim (K/V) scoreboard, ammo consumed, advance rates, etc. In general the inputs to generation models should be accepted physical system measures of performance (MOP) and decision rules which are both transparent and subject to audit trail analysis. We all know that an MOP at one level may well be an MOE at the next lower level. The products of the generation models become inputs to interpretation "models." The greatest deficiencies in the generation models today are the lack of internal time dependencies of the decisions made by the systemic models (i.e., no future projection state variable decision algorithms) and the lack of believable transitions between levels of the hierarchy.

As shown in Figure 1, generation models are represented as three basic types:

- > Large, complex models such as the Combined Arms and Support Task Force (CASTFOREM), Vector in Command (VIC), Force Evaluation Model (FORCEM), TAC THUNDER, etc., used to produce dynamic combat MOE's directly;
- > These same models used to produce outputs to more aggregated models such as the Combat Analysis Model (COMAN), ATCAL, etc.

- > To date, an essentially non-existent family of simpler, stand-alone, believable force-on-force models which produce more situation and question specific outcomes in a short response time environment (caused by the "realism vs simplicity" dilemma).

FIGURE 2



As distributed processing techniques mature, the concept of a "self-contained hierarchy" of generation models may become a reality. This realization will occur only if we accept the fact that software design and development must be initiated at least five years prior to its implementation (and probably longer, based on our records). Otherwise, we will be faced with outdated software and hardware implementations to be used as our generation models.

Characteristics of Interpretation "Models"

In many cases interpretation may be better described as a process than as a model. Interpretation may very well be an individual making a subjective judgment as to the answer to a question based

on a generation model output. That output may consist of data generated from another person's impression of the facts which pertain to the problem at hand or may be a post-processor of a systemic simulation model. Herein lies the scope of the problem we face. First and foremost, the process recognizes the existence of a multiplicity of weighting schemes, whether applied in the generation or interpretation model. In addition, the process represents the utilization of dynamically generated combat MOE's, coupled with appropriate weighting or scoring of these MOE's, to arrive at an answer to a specific question or possibly influence a decision made by a particular decision maker.

First, the interpretation model must either explicitly or implicitly consider those factors not represented in the generation model. Secondly, it must either interpolate or extrapolate the generation model results to the particulars of the question or decision. Thirdly, the process must either explicitly or implicitly assign weights to all factors related to the question, whether the factor was accounted for in the generation or interpretation model. Keep in mind that the interpretation model is nothing more than a quantitative or qualitative application of weighting (value) schemes to MOE results from whatever the form of the generation model.

Static Scores in Interpretation Process

The use of static scores in interpreters:

- > Must clearly establish context, since questions are clearly context sensitive.
- > Must be subject to rigorous evaluation, since there are many valid techniques for aggregation; some of which are amenable to mathematical rigor, some are not.
- > Must be subject to evaluation of the assumption that "linear" roll-up of results from the generator are acceptable with values attached to dynamically produced outcomes.
- > Could be used to assign "values" to weapon systems IN CONTEXT for a SPECIFIC decision, for analysis purposes.
- > Must strive to establish an understandable and believable link between analysts and decision makers by providing a structure which accommodates the decision makers' preference for value and risk.

What is Wrong Now

Weapons Effectiveness Index/Weighted Unit Value (WEI/WUV) and similar static scoring systems are a product of a qualitative attempt to deal with problems yet unsolved by the analytical community. It is not clear that the "decision making community" desires a quantitative basis for scoring, even if such a system

were possible. It may very well be that the problem lies, not in the development of quantitative scoring systems, but in the fear by the community that many "tuning parameters" may be removed from the process. In this regard, we must face the problem of what can realistically be considered quantitatively and what must be left as judgmental overlays, both in the generation and interpretation processes.

Use of models today is reactive to study demands, not proactive to fill the void required of generation models to feed interpretation models.

Linear, static, aggregate scores that are not based on acceptable generation model outputs are not desirable for either attrition or non-attrition analysis.

The need for macro, quick turn around analysis methods/tools that are objectively based is not currently being filled.

The majority of models are used for purposes other than providing macro/analytic methods.

Limitations of Static Scores as generators: (a) dynamics of combat are not included, but are critical, (b) impossible to analyze cause and effect, hence negating audit trail analyses, (c) no assessment of uncertainty, (d) mathematically bankrupt as generators of results and/or proxies for same, (e) context of the static score both limited and uncertain (i.e., what is the context of this number I am about to use?).

Where Should We Go?

Separate generation and interpretation functions.

Identify specific requirements for new generation models and for proactive use of existing ones. This requires a new focus not currently present in the management and use of our analytical tools. The first task of the proposed group dedicated to generating the architectural solution to our problem is to determine the new focus. As a first cut a new focus implies using our analytical tools for applications beyond the boundaries of the agency which owns and executes the tool to satisfy imposed study requirement deadlines. This suggests a totally new "chain of command" to facilitate the integration of generation and interpretation models across Army, Air Force, Navy, and joint analysis.

Define the products required of the generation and interpretation models; what we have in hand today; and what we need to fill the voids. Obviously, one of our major problems today is timeliness of response vs an ever increasing demand for "realism," hence complexity.

"Model in every pot" is not the answer, especially with the advent of micro computers at almost every level of command. The

micro explosion forces us as the "analytical" community to determine and recommend the appropriate use of this explosion. Currently we are well behind the power curve to assist the operational community in this regard.

Must initiate a focused effort to develop alternative macro analytic methods to judgmental scores for the generation model process, a currently unfilled challenge to the modeling community.

Chair Opinion

We, as modelers, have "copped out" long enough. The reason our products require so much interpretation is that we have focused on the "easy physics/engineering" modules and have not focused on the hard parts such as decision making, support functions, delay implications, etc. We must walk a fine line in our generation models between "tuning parameters" and those which can be subjected to either data or sensitivity analyses considerations. We have been in the "band-aid" mode far too long. Our "comfort zone" approach is no longer acceptable if we are truly dedicated to a viable alternative to the current way of doing business.

How Do We Get There?

Identify precisely who the current users of static scores are and the specific decisions with which they deal.

For each of these, design an alternative approach using the concepts described in the previous section.

Develop a catalog of appropriate generation models (not the all-inclusive book) which focuses on the interpretation models it could feed and the associated questions/decisions it could support.

Clearly identify which key decision parameters are included in generation vs interpretation, along with a concise specification as to how each is considered in the analysis.

Develop some "menu driven" interpretation models appropriate for specific classes of decisions. IT MAY BE THAT A LINK-UP WITH THE MODERN AIDS TO PLANNING PROGRAM (MAPP) GROUPS MAY SERVE A USEFUL PURPOSE IN THIS REGARD.

To the extent possible, develop quantitative linkages and coordination between specific generation and interpretation models.

What are the Interim Solutions?

Net assessment applications of scores may be piece-wise linear, obviously requiring a disciplined approach to use of current scoring systems.

Immediately stop development of static scores as generators and focus these resources on explicit methods for assigning weights, consistent with a formal structure, which directly relate to dynamic MOE's produced by acceptable generation models.

Recognize that the transition will not occur over night. It represents, to some users, a new way of doing business.

Establish an appropriate group to continue deliberations and make concrete recommendations to the DUSA-OR. This group should be established as soon as possible to assure that the motivation for solution to this dilemma is not lost.

The Challenge

You, as the decision maker, must provide enough information regarding the question so that the analyst can formulate quantitatively attainable MOE's to address the question. You, as the analyst, must establish the link to the decision maker in terms of value and risk associated with the question, as well as in the context of the answer required. Static scores are an artifact of our OR past, yet they remain a fixture in our current decision process. Is this the fault of our current generation models, our lack of future state forecasting capabilities, or is this, in fact, not a fault at all? The answer lies in a direct confrontation of the problem by both the decision making and the analysis community.

APPENDIX A
TERMS OF REFERENCE
MORS WORKSHOP ON COMBAT SCORING SYSTEMS

TERMS OF REFERENCE
MORS WORKSHOP
on
STATIC WEAPONS SCORES

Background

The Military OR community and those decision-makers who use its products have long felt the need for a relatively simple system of measures of effectiveness for weapons, units, and forces to use in net assessments, trend analyses, simple models of conflict, prioritization, and for other purposes. Typically, the general concept underlying these systems is that each weapon has an associated "score" and these, with appropriate modification, can be summed to get a total score for a unit or a force. The history of the development of the scores is a long one, and the degree of sophistication of the various schemes ranges from simple counts of people and weapons to those requiring a catalog of results of computer simulations and games. Although some analysts have called for the abolition of this kind of simple measurement, and others have questioned the specific uses for which they are being computed, they have been and will continue to be used to assist in many decision processes.

Because of the degree of disagreement within our community as to the validity and appropriate use of such scores, the Deputy Under Secretary of the Army (Operations Research) has suggested, and the MORS Board of Directors has approved in concept, the convening of a Workshop on Static Weapons Scores (Force Potential MOE) to be held in November 1986.

Objective

The main objective of this workshop is to discuss and evaluate existing weapon scores and estimate the need for and desirable characteristics of future measures of this kind. It is hoped that a wide range of agencies will be represented, including each of the Military Services, OSD, OJCS, CIA, DIA, and civilian contractors.

Scope

The workshop will entertain discussion of the many weapon and unit scores in existence, their methods of development, and the relationship between the MOE and their intended and actual use. Both those designed for independent (static) use and those designed to input to dynamic combat models will be considered. Among the questions that might be addressed are:

o Is there a basis in historical data to validate the use of a particular set of scores for a particular purpose? For example, many aggregated combat models use ratios of scores to drive the commander's decision process and to assess unit level combat outcomes and FEBA movement. Some analyses have attempted to correlate casualty rates and FEBA movement with force ratios using historical data, but with little success.

o Is there a set of problems for which scores derived from simulation-based killer/victim scoreboards are both useful and valid? What are the mathematical difficulties with this approach?

o Does the creation of model hierarchies obviate the need for aggregated weapon scores? If not, how do we accommodate them in models of different degrees of resolution?

o What are the alternatives to expressing the value of a unit as a linear or non-linear combination of that unit's individual weapon scores? The very concepts of "unit" and "combined arms" are based on the idea that we can add to effectiveness by the way we organize and train. How can scores represent this dependence of effectiveness on mix?

o Similarly, what are the alternatives to expressing the value of a force (air, ground, and naval) as a combination of unit scores?

o How and to what extent can and should a unit's score be modified to represent different activities and locations on the battlefield?

o To what extent can the value of a weapon system be expressed as a weighted sum of selected characteristics (mobility, survivability, lethality, etc.) of the system? Can we add to the validity of this approach by computing multiple sets of values?

o Are there particular categories of weapon systems to which scores should be applied when simulating decision making? Do these categories vary with the tactical echelon and the tactical mission of the simulated decision maker? Are there categories of decisions for which weapon scores should not be used?

o In the simulation of the decision-making process, when should the static scores for the simulated decision maker be computed on the current status of the force, and when should they be based on a projected force status related to execution?

The scope of the workshop does not include the endorsement of specific methods or approaches, although individual participants will be encouraged to provide examples, insights, suggestions for improvement, etc. Similarly, the scope does not include recommendations for changes in specific ongoing efforts, but the

results of the workshop should provide a better foundation of understanding on which to base such changes.

Agenda

It will be the responsibility of the chair to develop a detailed agenda. It is envisioned that there will be a general session devoted to the education of participants as to what measures have been and are being used and for what purposes. The workshop would then divide into sub-groups for detailed discussion of the issues. While the composition of the sub-groups will be left to the discretion of the chair, one possible division is:

- o Mathematical issues.
- o Use of weapon scores in dynamic models.
- o Use of static measures independent of dynamic models.

After separate subgroup meetings, the entire workshop will then reconvene to report findings, to integrate results, and to prepare a draft paper/briefing of the highlights. The chairs of the workshop and subgroups will meet after the workshop to the extent necessary to finish a timely white paper, article for PHALANX, and a briefing.

Membership

The workshop chair will be Dr. Sam Parry, from the Navy Postgraduate School. The chair will control membership so that it falls in a range of 35 to 45. Active use will be made of members of appropriate MORS working groups. From applicants responding to the announcement of the workshop, priority will be given to those individuals with the most relevant experience bearing on the discussion of static weapons scoring systems.

APPENDIX B

ATTENDEES

MORS WORKSHOP ON COMBAT SCORING SYSTEMS

ATTENDEES AT COMSCORS WORKSHOP
November 12-14 1986

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APPENDIX C

AGENDA

MORS WORKSHOP ON COMBAT SCORING SYSTEMS

COMBAT SYSTEMS SCORING WORKSHOP
AGENDA

WEDNESDAY -- 12 NOVEMBER 1986

0745	ARRIVE NAVAL POSTGRADUATE SCHOOL -- CHECK-IN, MAIN LOBBY, INGERSOLL HALL	MORS OFFICE
0815	CONVENE, INTRODUCTION -- INGERSOLL 122	SAM PARRY
0845	HOST WELCOME MORS WELCOME	ADMIRAL AUSTIN DICK GARVEY
0900	KEYNOTE	WALTER HOLLIS
0930	INTRODUCTION OF WORKING GROUP LEADERS CHARGE TO GROUPS ADMINISTRATIVE ANNOUNCEMENTS	SAM PARRY DICK WILES JOE STEWART
0945	BREAK	
1015	PRESENTATION OF WORKING GROUP GOALS {15 MINUTES EACH}	WORKING GROUP LEADERS
1100	LUNCH -- NPS OFFICERS CLUB	
1215	WORKING GROUPS CONVENE MATHEMATICS -- INGERSOLL 369 ATTRITION PROCESSES -- INGERSOLL 325 AT 1300 -- INGERSOLL 323 NON-ATTRITION PROCESSES -- INGERSOLL 122	
1430	BREAK	
1700	WORKING GROUPS ADJOURN {WG LEADERS, FLOATERS MEET WITH SAM PARRY IN 122}	
1715	MIXER -- NPS OFFICERS CLUB -- LA NOVIA TERRACE ROOM	

THURSDAY -- 13 NOVEMBER 1986

0745	COFFEE AND DONUTS -- OUTSIDE INGERSOLL 122	
0830	CONVENE -- INGERSOLL 122 -- ADMINISTRATIVE ANNOUNCEMENTS	SAM/DICK
0840	SPECIAL PRESENTATION -- GENERALIZED VALUE SYSTEM -- NPS RESEARCH	CPT BOB KILMER
0920	OTHER SCORING SYSTEMS	WAYNE HUGHES
0945	BREAK	

0955	PRELIMINARY WG REPORTS {20 MINUTES EACH}	WG LEADERS
1100	LUNCH	
1215	WORKING GROUPS CONVENE AS ON WEDNESDAY	
1430	BREAK	
1700	WORKING GROUPS ADJOURN {WG LEADERS, FLOATERS MEET WITH SAM PARRY IN 122}	
1800	COCKTAILS AT THE MARK THOMAS OUTRIGGER	
1900	DINNER AND INTERACTION WITH BRUCE PRISS	

FRIDAY -- 14 NOVEMBER 1986

0745	COFFEE AND DONUTS -- OUTSIDE INGERSOLL 122	
0800	WG REPORTS -- INGERSOLL 122 {20 MINUTES EACH}	WG LEADERS
0900	WORKING GROUPS RECONVENE -- SAME ROOMS	
1100	LUNCH	
1215	WG REPORTS -- INGERSOLL 122 {40 MINUTES EACH}	WG LEADERS
1415	SUMMARY	
1500	ADJOURN	
1500	INITIATE PREPARATION OF REPORT AND BRIEFING	SELECTED PERSONS

COMMITTEE

CHAIR -- SAM PARRY, NAVAL POSTGRADUATE SCHOOL
 COCHAIR -- CDR JOE STEWART, NAVAL POSTGRADUATE SCHOOL

WG LEADERS --

MATHEMATICS -- PETER CHERRY, VECTOR RESEARCH INC.
 ATTRITION PROCESSES -- DAN SHEDLOWSKI, USA CAA
 NON-ATTRITION PROCESSES -- KEN LAVOIE, AU/CADRE

END

DATE

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